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by the lustrous pale green color of the leaves. A form of ***Pogonatum alpinum*** which Prof. Holzinger thinks closely resembles var. ***Macounii*** (Kindb.) T. C. Frye[1] forms thick deep mats over portions of the dry shaded ledges and, if one has patience and a microscopic eye, what at first glance seems to be a stain on the back of some shallow niche in the limestone face will, upon close inspection, prove to be *Seligeria pusilla* (Ehrh.) B. & S., one of the exceedingly minute mosses that is no less rare than it is attractive.

Just a short distance east of the cliff, where a small spring trickles over the rocks, a dripping curtain of *Didymodon tophaceus* (Brid.) Juratz with the lower portions of the stems so thickly encrusted with lime as to be noticeably brittle, brings to a close what seems to be rather a noteworthy aggregation of rare mosses from one restricted locality within less than one hundred miles of New York City. Further search will no doubt reveal new finds, but when one can supplement the above list with such species as *Timmia cucullata*, *Pohlia Lescuriana*, *Barbula fallax*, *Trichostomum cylindricum*, *Bartramia Oederi*, etc., it is easy to imagine what a perennial source of pleasure such a place may be, especially when it is within sight of one's front door.

I am under obligation to Prof. Holzinger and Mr. R. S. Williams for their kind and patient assistance in the determination of many of the above-mentioned mosses.

BUSHKILL, PA.

SPHAGNUM USED AS SURGICAL DRESSING IN GERMANY DURING THE WORLD WAR

J. W. HOTSON

[*Concluded*]

SOURCES OF SPHAGNUM MOSS IN GERMANY

Sphagnum bogs containing the best moss for surgical dressings are found in cool, humid regions; consequently few bogs are found in France or Belgium, while in Germany as in Scotland and Ireland, they are very abundant, especially in the Bavarian Alps, Bavarian Forest, in Spessart, Rhön, etc., where extensive "raised bogs" frequently occur. These bogs are somewhat dome-shaped, something like an inverted saucer, so that the center of the bog is often ten or fifteen feet higher than the edge and all built up of sphagnum and plants associated with it. Extensive bogs, often with an open lake in the center, also occur in eastern and northeastern Germany, so that the Germans had at their disposal an inexhaustible supply. Kronacker writing from München in 1916 on the subject of moss dressings says "The lack of sphagnum moss can never be felt. Everywhere in the beautiful German forests it stands at our disposal, growing luxuriantly,—no blockade can present itself as an obstacle here." It was through one of the open bogs of Poland that a German officer ordered his men to attack the retreating Russians, when practically the whole regiment sank out of sight. The officer himself escaped but became mentally unbalanced as a result of this catastrophe.

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[1] *cf.* **Exsic. Holzinger, Musci Acro. Bor.-Amer.** ***No. 417.***

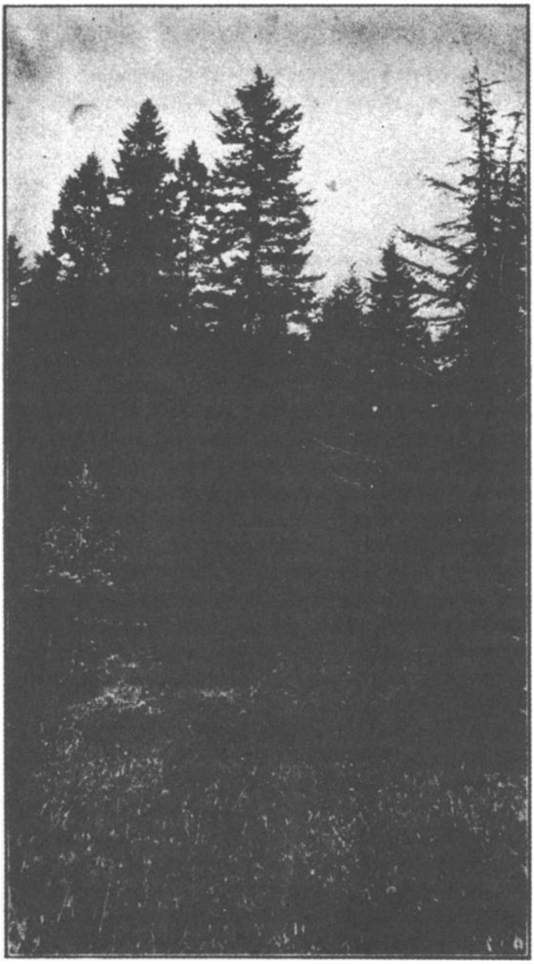

FIG. 9. In the foreground are Sphagnum, Labrador Tea (Ledum), Cranberry, and Swamp Laurel (Kalmia). In the background are Conifers with certain deciduous shrubs between.—From photograph by Prof. G. B. Rigg.

In collecting and cleaning the moss the Germans do not seem to have used the same care that we did. There is little doubt, as we found out later, that we were too particular in the process of cleaning. Both the Germans and British put less time on its preparation than we did. It is not necessary to remove absolutely everything from the moss as we tried to do. Such soft pliable materials as small pieces of leaves of trees or grass are not detrimental to the absorbing power of the moss unless the quantity is enough to separate the particles of moss so that they are not in contact. Anything harsh, however, like twigs or pine needles that are apt to penetrate the dressings and irritate the wound are decidedly objectionable.

After the moss was cleaned, that is, freed from all the woody material, the Germans recommended that it be washed at wells or streams. The moss was then dried in the sun, at stoves, or in a kiln. With our moss we did not feel that washing was necessary or even desirable as it required additional trouble in drying.

It is interesting in looking over the work done with sphagnum by the Germans, British and Americans to see how closely they have followed each other. It is natural to expect that the methods of the Americans and British might be similar because besides being allies, the methods of the one were known to the other. In fact, practically all the information we had concerning sphagnum used as a surgical dressing was obtained from the British. The Germans, however, were practically isolated with little or no communication with us, and yet they have followed along almost the identical lines of the British and Americans, with, of course, slight modifications which will be noted as we come to them.

After a general survey of the work done with sphagnum, one might divide the dressings or pads into two broad groups; those made of the loose moss and those made of compressed moss, the so-called sphagnum compresses. There are several modifications within each of these groups, both as to size and method of making the dressing, especially with those made of loose moss. The size of the pads was determined in general by the need, but the width of the muslin for the encasements was taken into account in order that there would be no waste.

DRESSINGS MADE OF LOOSE SPHAGNUM MOSS

The commonest dressing seems to have been made of loose moss much like the ones described as the British type of pad.[2] After all the foreign material was removed from the moss it was dried and an appropriate amount put into muslin sacks which were then sewed up. These were made of various sizes according to the specific need. The very large ones were quilted or knotted at definite and suitable intervals in order to keep the moss from shifting. It will be remembered that this was the type of pad that was first made at the University of Washington when the faculty and their wives were making dressings for the French relief, but was replaced by the second type when they began work under the direction of the American Red Cross. By far the greatest number of sphagnum dressings made in Great Britain and Germany during the war was of this type. It was this type of dressing to which many American surgeons objected.

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[2] J. W. Hotson. Sphagnum as a surgical dressing. Published by the Northwestern Division of the American Red Cross. A copy of this article may be had by writing to the author, University of Washington, Seattle. Wash.

The second type made from loose moss might be designated as the American type,[3] although both the British and Germans made similar ones, but not nearly as elaborate as the ones made by the American Red Cross. Certain modifications of this type of pad are distinctly American.

Hasenbalg, writing shortly after the war broke out in 1914, describes the German method of making this type of dressing about as follows: Over a flat frame, resembling a photographic developing frame a correspondingly large piece of muslin is placed. The frame is then filled with a mixture of moss and surgical lint. It is pressed together as firmly and equally as possible. The free ends of the muslin are then folded together over the frame and fastened with a few stitches. Wounded soldiers were employed to great advantage in making these pads.

The American method of making this type of pad is somewhat different from the German, being much more elaborate. In making this dressing a piece of Scottissue (thin wood-pulp paper) of appropriate size is placed on the table and on it a wooden frame corresponding to the particular size of dressing to be made. The frame is filled evenly with moss but not packed. Over this a thin layer of non-absorbent cotton is placed and the frame removed. The margins of the Scottissue are then folded over the cotton and sphagnum. A thicker layer of non-absorbent cotton is put on the back of this incomplete dressing and the whole encased in a piece of gauze of appropriate size, which may or may not be stitched at the back. The pad is then passed through an ordinary clothes-wringer in order to press the sphagnum into the cotton and thus tend to keep the moss from shifting.

Sometimes, as described by Korach, the moss plants were broken up into a coarse powder. A quantity of this material was filled into small muslin bags of very fine weave so that the fine particles would not escape as dust. These were used as daubers in operations instead of the much dearer muslin ones. It was found, however, that for daubers sphagnum is less suitable than cotton and almost entirely useless for plugs, especially for the ears and nose. It was also found to be of little value as a dressing for the eyes.

Large, thick pads made of loose moss were used and did excellent service for invalids who were suffering from diarrhoea or involuntary discharge of the urine. When pads of this kind were changed frequently the disagreeable odor of the urine was hardly noticeable. Although, in general, sphagnum dressings were used only once, yet at times they were dried, treated with formaldehyde or other disinfectant and used repeatedly as an absorbent.

Quite serviceable pillows were also made from loose sphagnum. The moss was cleaned, the coarser, foreign material removed, then washed and dried. Coarse muslin or cotton sacks, used as pillow cases, were well filled with this material and sewed up. These pillows were used to good purpose as couch pillows after being sprinkled with some mild disinfectant, like boric acid, dried and then covered with cambric linen. These couch pillows were used for different purposes; first, for very sick persons as rests under the hips and in the small of the back instead of rubber or straw pads; second, as supports or for bolstering up the arms and legs of wounded people, particularly when the limbs were broken; third, they were especially serviceable in hospital trains for rests for the head and neck.

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[3] J. W. Hotson. Sphagnum from bog to bandage. Publications Puget Sound Biological Station, **2**: 211–247, No. 47, 1919.

Moreover, large, absorbing, quilt-like pads made of loose sphagnum, as well as the smaller surgical dressings, were found very valuable in maternity cases. This moss was also used as napkins and diapers for infants and young children. This was also a common practice among our North American Indians. In Alaska they still use it in this way. It was also adopted quite generally by Dr. Walton Haydon during his six years (1878–1884) medical experience at Moose Factory on the Hudson Bay while in the service of the Hudson Bay Company.

DRESSINGS MADE OF COMPRESSED SPHAGNUM MOSS

The Germans were very skilful at making sphagnum compresses or pasteboard compresses as they were sometimes called. In preparing the moss for this purpose all foreign material was removed and the stems and leaves of the moss more or less broken up or pulverized. These were packed into a frame structure and subjected to a heavy pressure, thus pressing the moss particles into flat cakes resembling cardboard. These compresses were cut into different sized pieces according to the dimensions of the pad needed, wrapped in muslin and sterilized. The compresses were not applied directly to the wound, but usually used as an outer dressing, a thin layer of gauze or cotton being first applied. As one would naturally expect, the compresses were somewhat hard and stiff, but they became soft and pliable after sterilization with steam heat, so that they fitted closely to the body and absorbed excellently. If these dressings were large, however, the particles composing them tended to separate, thus making the dressing less effective. To avoid this disintegration it was often advisable, after the cardboard had been cut into pieces of desirable size, to sew them into the muslin encasements before sterilization. Dressings made in this way were shown to absorb ten times their weight of fluid.

Because the surface of these dressings was somewhat hard they were frequently sprinkled slightly just before application with sterile water, weak solution of sodium chloride or some other mild disinfectant. These compresses were usually placed between pieces of gauze just the same as the cotton compresses were.

When an extra heavy pressure was applied these compresses became like pasteboard, stiff and hard. Such material was used as splints for binding up broken arms or legs.

The American Red Cross had just begun to experiment with these compresses when the armistice was signed so that none were sent over seas. The British, however, made a great many sphagnum compresses of this type during the war, both for dressings and for splints. The following account has been sent me by Miss Margaret Leechman, supervisor of sphagnum compresses at Edinburgh, Scotland.

COMPRESSED MOSS DRESSINGS AS MADE IN EDINBURGH, SCOTLAND

Compressing sphagnum moss was a new experiment to Scotland and even at the end of three and a half years we could not make compressed moss dressings anything like the German ones, to give the devil his due.

Of course, all the moss sent to our department was supposed to be cleaned. Our first process was sublimating it, unnecessary, I believe, as it was always sterilized before it was used, but it was a precautionary measure. For sublimating we had a large porcelain bath with a wringer and a traveling band attached to one end. The sublimate was the usual mixture of perchloride of mercury. The worker who soaked the moss had also to spread it evenly over the band, so that in going through the wringer it all got an equal pressure. As only 28 ozs. of sublimate to a pound of moss was allowed to remain in after it had been through the wringer, we had to be fairly particular. At the other end of the band it fell off into a sack fixed there for the purpose. Another worker's job was to remove these sacks when full and pass them on into the drying room. This was just a long room with drying trays on either side, as high up as we could manage them. These trays were wooden frames with wire netting across the bottom; the lowest one had a piece of mosquito netting over the wire to prevent the smaller pieces of moss falling through to the floor. The heat in this room was anything from 80° to 118° F. We tried not to work in it when it was the latter. When the moss was dry it was emptied into long deep boxes on castors, also known as tanks, and these when filled, were pushed into the next room where the dressings were actually made.

In this room the moss was first weighed out, 4½ oz. or 4 oz. into basins, then it was taken over by the first of four workers, who emptied it into a wooden frame three inches deep, covered over with a thin piece of cloth, 4½ oz. of moss into a frame 12" x 14", 4 oz. into a frame 10" x 14". The next worker smoothed out the moss, packed it well into the corners, then slid it on to the next. We found that the firmness of the compressed cake depended almost entirely on how it was packed. The third worker pressed it firmly down with a compressed air machine (weight 300 pounds) made for the purpose, while the fourth folded the cloth tightly over the moss, but still keeping it in shape, then lifted away the frame and laid the cake on a zinc tray. There it remained until nine others were laid very exactly on the top of it, making a pile about 20 inches high. This pile was then put under a hydraulic press and compressed to the height of about three inches. We tried various different machines for compressing, from 80 tons to 200 tons pressure, and we found 160 tons about the best. After compressing, the cloths were taken off the cakes, their edges trimmed and cut into our various sizes of dressings. The sizes were usually as follows: 12″ x 14″ cakes into 6″ x 7″ or 4″ x 7″; 10″ x 14″ cakes into 7″ x 10″. Sometimes we were asked for whole cakes but in such cases they were mostly used for pads, being too large for an ordinary dressing. We sewed our dressings into muslin bags, one inch larger all around than the dressing, to allow for swelling.

STERILIZATION

Moss used for surgical dressings must be thoroughly disinfected or sterilized. The common method of sterilization used by the Germans was steam heat. At first the method recommended was to expose the moss to steam heat for 24 hours. This was found to be injurious to the moss so that, as a result of further experimentation by Korach in 1915, it was changed, limiting the time of sterilization to one-half hour, by which the ability of the moss to absorb water was not impaired.

In some cases where the dressings were used as bed pads the sterilization was considered less necessary, and was sometimes omitted. These pads were, however usually saturated with an antiseptic and then dried before using. At other times the moss was washed with an antiseptic, such as corrosive sublimate (1–1000) or with potassium permanganate (1–1½) and then thoroughly dried and made into pads.

APPLICATION OF SPHAGNUM DRESSINGS

The application of these dressings was very simple. They were used almost entirely as outer dressings. The wound was covered with a thin gauze dressing first and the moss pad placed on it and bound up. They were usually fastened over the wound with a bandage or the smaller ones with adhesive tape. These remained unchanged for one, two, or three days, or even longer—much longer than the fine muslin or cotton dressings could be left. As soon as the moss began to absorb the liquid it became soft and pliable, fitting closely to the body.

What are some of the things for which sphagnum may be used other than surgical dressings?

Sphagnum is the only moss for which any very important economic use has been reported, and the more it is studied and experimented with the more varied and extensive are found to be its uses. The last word has not yet been said about sphagnum and the economic uses to which it may be applied. It makes an excellent insulator, much better than sawdust or even cork. Many Germans used it during the war in their homes for keeping milk warm or cool. The inside of a wooden or paper box was well lined with it, thus acting as an insulator, and bottles of milk put in the center.

In Sweden some of the coarser kinds of paper, like wall-paper, wrapping paper and building paper are made from this moss, while in Germany a fairly good and cheap cloth is made by mixing it with wool and weaving them together.

It is well known the part this moss plays in the formation of peat, as well as the common use nurserymen make of it in packing plants, especially where moisture is required for a considerable time about the roots. Varieties of orchids are known to thrive as well in sphagnum as in their native haunts.

What are some of the advantages of sphagnum moss dressings as recorded by German writers?

(1) Its high absorptive power.

The results of careful experiments carried on at Hamburg by Korach in 1915 have re-demonstrated the superiority of the absorption of sphagnum. These results show that peat absorbs six times, wood pulp seven times, and sphagnum ten times its dry weight of fluid. You may recall that the result of similar experiments in America show that absorbent cotton absorbs four to six times its weight according to the quality, and sphagnum as high as twenty times its dry weight. Any moss absorbing ten times its weight or less was discarded by the American Red Cross. Not that this was unsuitable for dressings, but because sufficient material with an absorbency from sixteen to twenty was available.

(2) It is cool and soothing.

Because the moss is so porous it dries rapidly. This evaporation keeps the wound cool and the cooling soothes. This drying of the secretion takes place so rapidly that even after an operation where the wound has bled quite freely the dressing was found comparatively dry after 24 to 36 hours. In consequence of this ability to dry quickly, which is dependent on the porous quality of the sphagnum, the moss dressings are peculiarly fitted for permanent bandages, such as are desirable in the transportation of wounded people considerable distances.

(3) The dressings can remain a long time without changing.

This fact saves much time and work for the surgeon and pain for the patient. Not infrequently soldiers wounded on the field were transported to the home hospital in the first dressing.

(4) Its behavior in not being subject to disintegration even when it is dead or permitting this disintegration to take place in its surroundings.

(5) It is a produce of the home land, where "no blockade can present itself as an obstacle."

(6) It is abundant and cheap.

What are the possibilities for the manufacture of these dressings becoming a commercial enterprise?

The manufacture of sphagnum dressings on a commerical scale should be a very profitable one if some cheap method of cleaning the moss could be devised and thus avoid doing it by hand. Both the northern Atlantic and Pacific coasts, where the moss is abundant and of a high grade, should be very promising localities for carrning on this work. There are two firms manufacturing these dressings in Portland, Oregon, and at least one, possibly more, prospective one in the New England States, while in Detroit efforts are being made to perfect machinery for cleaning and preparing the moss for dressings. In Scotland such an apparatus has already been invented by the Rev. Adam Forman of Beattock near Edinburgh, and these moss dressings are being made and sold by at least one large firm in London. In Germany there are several such firms.

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